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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/841,817	04/24/2001	Chih-Ning Wu	JC-6987-C	6297

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EXAMINER

KORNAKOV, MICHAEL

ART UNIT

PAPER NUMBER

1746

DATE MAILED: 04/23/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

A9-5

Office Action Summary

Application No.

09/841,817

Applicant(s)

WU ET AL.

Examiner

Michael Kornakov

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 04 April 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) 10-20 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-9 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☒ Claim(s) 1-20 are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☒ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other:

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of claims 1-9 in Paper No. 4 is acknowledged. Claims 10-20 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in Paper No. 4.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

4. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein

were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 1, 4, 8 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicants' admission in view of Tamaoka et al (U.S. 6,232,237), and further in view of Bowden et al (U.S. 5,320,709).

Applicants discuss **conventional** cleaning method of the dual damascene opening. The said opening is formed by etching the dual damascene structure generally having conductive wire and low-k dielectric layer. Particularly, the dielectric layer 106 and cap layer 104 are etched, thus exposing the metal layer 102. The material of the cap layer is **silicon nitride** (Specification, page 1, lines 15-23; page 2, lines 1-5; Fig.1). The conventional cleaning method of dual damascene opening, disclosed by Applicants, includes the step of wet treatment the dual damascene opening followed by argon sputtering step to bombard the metal oxide for removing the polymer residue before the second metal layer fills in the dual damascene opening 108. In the wet treatment step amine-based organic solvent is utilized (Specification, page 2, lines 11-14). Thus, Applicants admission of the prior art meets the limitations of the claimed process in terms of its steps.

The admitted prior art method differs from the instant claims by reciting an amine based organic solvent vs. fluorine-based organic solvent used in the post-etching cleaning step.

Tamaoka teaches forming an opening in the semiconductor structure, which comprises the layers of dielectrics and conductive materials, among them silicate based low k dielectric, and interconnection metal layer. (Fig. 3 E-3G, col. 5, lines 12-41). Tamaoka specifically indicate that during the conventional cleaning with organic cleaner, such as an organic solvent containing an amine group, part of the low k layer exposed on the side wall of the via hole is unintentionally etched to form concave portions, which complicates further processing (col.6, lines 50-64), thus motivating the skilled artisan to utilize the cleaning process **without the drawbacks of amine-based organic solvents.**

Bowden teaches an improved method for selectively removing of residues from vias, i.e. from pathways connecting layers in a multi-layer chip pattern (col.1, lines 49-52). Bowden utilizes anhydrous **ammonium fluoride dissolved in polyhydric alcohol** (col. 2, lines 61-65). This reads on the limitations of the instant claim 1, read in light of the instant specification, and on the limitations of the instant claim 3.

Since Tamaoka discredits amine based solvents for post-etching cleaning of vias with exposed metal line and low K dielectric material, and since Bowden teaches a method for selectively removing organometallic and organosilicon residues from vias with the use of specific fluorine based organic solvents, a person skilled in the art, motivated by teaching of Tamaoka and Bowden, would have found it obvious at the

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time the invention was made to utilize anhydrous ammonium fluoride dissolved in polyhydric alcohol of Bowden, in lieu of amine solvent in the process of Applicants' admitted prior art, in order to avoid etching of low K dielectric material during the cleaning procedure, and to ensure the removal of unwanted residues and oxides from exposed damascene structures, and thus to arrive at the instantly claimed subject matter.

6. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Applicants' admission in view of Tamaoka et al (U.S. 6,232,237), further in view of Bowden et al (U.S. 5,320,709), and further in view of Wu et al (U.S. 6,440,873).

The combined teaching of admitted prior art, Tamaoka and Bowden provide for the use of fluorine based organic solvent, as discussed above.

They do not disclose the use of fluoride acetate acid, as per instant claims 2 and 3.

Wu discloses post metal etch cleaning method which begins by providing a wafer with an etched metal layer formed thereon, wherein the etched metal layer is covered with a polymer residue. A fluorine based organic acid solvent is used to clean the metal layer, followed by removing the solvent by a physical method (abstract). The fluorine based organic acid solvent may contain, acetyl fluoride (CH_3COOF , which is a synonym of fluoride acetate acid) acid solvent, such as the ACT NE series solvent prepared by Ashland Co., Ltd. company, U.S.A. This kind of solvent includes a chelating agent to chelate with metal from the metal line (col. 2, lines 46-55).

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Since Bowden motivates a person skilled in the art to utilize organic fluorine based solvents due to their ability to dissociate without formation of hydrogen fluoride compound (col. 2, lines 40-55), a person skilled in the art would have found it obvious at the time the invention was made to utilize acetyl fluoride acid of Wu, as a low ionization specie, as suggested by Bowden, in order to maintain the pH of cleaning solution primarily neutral, to avoid unwanted reactions and thus to arrive at the subject matter of the instant claim 2.

7. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Applicants' admission in view of Tamaoka et al (U.S. 6,232,237), further in view of Bowden et al (U.S. 5,320,709), and further in view of Wu et al (U.S. 6,440,873), and as evidenced by Fang et al (U.S. 6,293,848).

It is first noted that the instant specification provides absolutely no guidance as to what kind of chelating and oxidizing agents are used along with fluoride acid solvent. Therefore, examiner interpreted the claimed limitations in a broadest possible manner.

The evidence is provided from Fang to meet the limitations of claim 3, that chelating agent can also serve as an oxidizing agent.

Fang states that some compounds can function both as a chelating and an oxidizing agent (e.g., certain ferric nitrates and the like) (col. 4, lines 60-65). Therefore,

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it would have been obvious to a person skilled in the art to employ chelating agents named by Wu as both chelating and oxidizing agents with the reasonable expectation of success.

8. Applicant **has not provided evidence** in this file showing that the invention was owned by, or subject to an obligation of assignment to, the same entity as U.S. Patent 6,440,873 at the time this invention was made. Accordingly, U.S. Patent 6,440,873 cannot be disqualified as prior art through 35 U.S.C. 102(e), (f) or (g) in any rejection under 35 U.S.C. 103(a) in this application.

9. Claims 6 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicants' admission in view of Tamaoka et al (U.S. 6,232,237), further in view of Bowden et al (U.S. 5,320,709), and further in view of Denning (U.S. 6,187,682).

Combined teaching of Applicants' admission in view of Tamaoka and Bowden discloses the process identical to the instantly claimed process, but does not specify numerical parameters of sputtering, as per instant claims 6 and 7.

Denning utilizes argon sputtering in a process of cleaning a dual damascene opening having exposed layers identical to those instantly claimed (paragraph, bridging col.8 and 9, Fig. 8, 9). A sputtering power for accelerated cleaning of such structure according to Denning can be 300-500 W (col.5, lines 30-50), thus disclosing the end point of the range identical to the end point of the claimed range. Therefore, a person skilled in the art would have it obvious to utilize the range of power, as suggested in

Denning in order to remove contaminants from the dual damascene structure in timely manner in the analogous cleaning step of the above combination of references with the reasonable expectation of success.

With regard to the limitations of claim 7 concerned with the time of sputtering, Denning provides a clear motivation to optimize the time in order to get satisfactory level of cleaning (col. 8, lines 24, 25), thus recognizing time as a result effective parameter. It is also held by the Courts that discovery of optimum value of result effective variable in known process is ordinarily within the skill in the art and would have been obvious, as per *In re Boesch and Slaney* 205 USPQ 215 (CCPA 1980).

10. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Applicants' admission in view of Tamaoka et al (U.S. 6,232,237), further in view of Bowden et al (U.S. 5,320,709), and further in view of Honda et al (U.S. 6,361,712) and as evidenced by Fang et al (U.S. 6,293,848).

The combined teaching is silent about the use of chelating and oxidizing agent, as per instant claim 5.

Addition of chelating and oxidizing agents into post-etch cleaning compositions is routinely used in the art.

Thus, Honda discloses a composition for selective removal of oxides, remaining after plasma etching of a substrate, having low k dielectrics and conductive wires, wherein the silicon nitride layer is positioned between the low k film and the metal wire (col.1, lines 7-10; col. 3, lines 47-49). The composition of Honda comprises **fluorin containing compound**, which can be of organic nature or ammonium fluoride (col.2,

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line 63; col. 3, line 6), water miscible organic solvents (col.3, lines 39, 49-54) and additives, such as chelating compounds, which enhance the effectiveness of cleaning composition of Honda in removing particulate and/or metallic contaminants from the wafer surface (col.3, lines 55-59) without damaging the low-k interlayers.

Since the process of Honda is analogous to wet cleaning step, described by a combination of references and to a wet cleaning step of the instant claims, and since it can be applied to damascene structures, it would have been obvious to a person skilled in the art, motivated by disclosure of Honda at the time the invention was made, to add the chelating agent of Honda in a cleaning composition of applied prior art in order to enhance removal of particulate and metallic residues by complexing metal ions with chelating agents.

The rationale for attributing the same compounds to chelating and oxidizing agents, as evidenced by Fang, is discussed supra and is incorporated herein in its entirety.

Therefore, the combination of admitted prior art and applied references renders the instant claims prima facie obvious and properly rejected under 35 U.S.C. 103 (a).

11. Additional references cited in PTOL-892 show the general state of the art.

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to Michael Kornakov whose telephone number is (703) 305-0400. The examiner can normally be reached on 9:00am - 5:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Randy Gulakowski can be reached on (703) 308-4333. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872 9310 for regular communications and (703) 872 9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308 2450.

M. Kornakov

Michael Kornakov
Examiner
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April 21, 2003